



An Energy Efficiency Workshop & Exposition

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Palm Springs, California

## *Counting the Benefits of ESPCs: Energy Savings and More*

Phil Wirdzek

*National Energy Manager*

*U.S. EPA*



## *EPA Energy Use*

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- ❑ The U.S. EPA collects energy and water consumption data from its 20 owned laboratories
- ❑ E.O. 13123: 20% reduction by 2005
  - Spirit of Executive Order to reduce emissions
  - Specifies laboratories as part of Federal energy reduction efforts
  - How do we get there?



## *NVFEL – Ann Arbor, MI*



June 2-5, 2002

[www.energy2002.ee.doe.gov](http://www.energy2002.ee.doe.gov)



## *National Vehicle and Fuel Emissions Laboratory (NVFEL)*

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### Background

- ❑ 135,000 square foot facility in Ann Arbor, Michigan
- ❑ Requires precise environmental control under widely varying load conditions
- ❑ One of EPA's most energy intensive sites
  - Using almost 3 MW per year
  - Over \$1 million in annual utility costs



## *NVFEL – Ann Arbor, MI*

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### The Need:

- ❑ 30 year old energy infrastructure in dire need of replacement. For example:
  - Test cell AHUs before ESPC conditioned 100% outside air to supply space, and air was then exhausted after the first pass
  - Baseline water consumption 31,373,000 gallons/year



## *NVFEL – Ann Arbor, MI*

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### The Answer? ESPC

- ❑ Reduce source emissions, energy consumption, and energy costs through 11 ECMs
- ❑ Exceed federal energy reduction mandates
- ❑ Eliminate CFCs
- ❑ Reduce water consumption
- ❑ Minimize wasted energy
- ❑ Provide simple payback on contractor's capital expenditure of less than 10 years
- ❑ NORESO



## *NVFEL – ECM 1*

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### Test Cell AHUs

- ❑ Replace 14 rooftop AHUs supplying the test cells
  - Removal of old units, steam piping, humidifiers, and exhaust fans
- ❑ New units installed with:
  - Indirect evaporative coolers, preheat coils, cooling coils with face and bypass dampers and spray atomizing humidifiers
  - New temperature controllers





## *NVFEL – ECM 1 & 2*



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## *NVFEL – ECM 2*

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### Soak Area AHUs

- ❑ Four roof-mounted HVAC units installed to serve soak areas
  - Water heated and cooled
  - Total energy recovery wheel installed to precondition air supply
- ❑ New temperature controls
  - Maintain space conditions
  - Remote monitoring of units, remote set point adjustment



## *NVFEL – ECM 3*

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### Office Preparation AHUs

- ❑ Removed 11 roof-mounted HVAC systems for offices, controls rooms, labs, and preparation rooms
- ❑ New units installed
  - Return air, preheat coils, cooling coils
  - New temperature controllers



## *NVFEL – ECM 4*

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### Replace Boilers and Chillers

- ❑ Provided NVFEL with entirely new heating and cooling plant
- ❑ Water chillers converted from CFC-based mechanical refrigeration to non-CFC, two-stage absorption technology
- ❑ High-pressure steam boilers removed, now generated by same absorption units



## *NVFEL – ECM 4 (cont'd)*

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- ❑ New cooling tower installed on roof
  - Removed existing one from site
- ❑ Existing 5,000 gallon fuel oil tank remains intact outside boiler room
  - Serves as back-up for dual fuel absorbers and for the emergency genset



## *NVFEL – ECM 4 (cont'd)*



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## *NVFEL – ECM 5*

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### Install Energy Management System (EMS)

- ❑ In the past, control of HVAC equipment was performed manually
  - HVAC systems ran excessively due to various occupancy schedules
- ❑ NORESO proposed and installed state-of-the-art EMS that controls building temperature, tracks energy usage, and controls HVAC equipment based on occupancy





## *NVFEL – ECM 6*

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### Process Water Conservation

- ❑ Use chilled water to cool process loads at the facility



## *NVFEL – ECM 8*

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### Power Factor Correction

- ❑ NVFEL is supplied with power by Detroit Edison under the Primary Supply Rate service classification
  - This rate structure includes a reactive demand charge for each kVA of lagging demand
- ❑ NORESO installed capacitors and controls to increase the facility power factor to at least 90%, the penalty threshold



## *NVFEL – ECM 10*

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### Natural Gas Fuel Cell

- ❑ Installed a 200 kW fuel cell powered by natural gas
  - Provides stable power
  - Converts natural gas into electricity to provide a quiet, clean and efficient on-site generating system
  - Dual cooling loops did not materialize
- ❑ Electric generation is working



## *NVFEL – ECM 10*



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## *NVFEL – ECM 11*

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### Cold Test Facility – Conversion to Central Plant Cooling

- ❑ Improved efficiency of Cold Test Facility chiller system by serving it with chilled water from the central plant



# *Results of ESPC*

*(January 1, 2001- December 31, 2001)*

ECM	Electrical Savings (kWh)	Water Savings (Gal)	Fossil Fuel Savings (Mtbu)
ECM -1 Test Cell AHU	2,282,727	6,636,761	50,296,092
ECM-2 Soak Area AHU	409,922	1,118,925	16,532,768
ECM-3 Office and Preparation Area AHU	1,249,443	1,913,020	14,212,372
ECM-4 Replace Boilers and Chillers	757,603	0	(9,719,424)
ECM-5 Install EMS	120,271	0	3,283,019
ECM-6 Process Water Conservation	(5,604)	11,422,149	(406,013)
ECM-8 Power Factor Correction	0	0	0
ECM-10 Natural Gas Fuel Cell	1,187,717	0	(7,966,809)
ECM-11 Cold Test Facility – Conversion to Central Plant Cooling	19,270	0	(71,739)
<b>TOTALS</b>	<b>6,021,350</b>	<b>21,090,854</b>	<b>66,160,265</b>





## *Measurement & Verification (M&V)*

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### M&V Plan : Documenting Energy Savings

- ❑ EMS tracks energy performance of new equipment
  - comprehensive data logging
  - EMS continuously logs variables and calculates energy usage by system
  - NORESO accesses stored data and sends to M&V group for processing



## *Measurement & Verification (M&V)*

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### Evaluating the M&V Plan

- ❑ Third party evaluation of M&V report
  - Architectural Energy Corporation (AEC)
- ❑ EMS tracks energy performance and calculates real time energy savings
  - AEC looked at each ECM to determine if EMS calculated energy savings as specified in M&V plan



# Control System Main Page



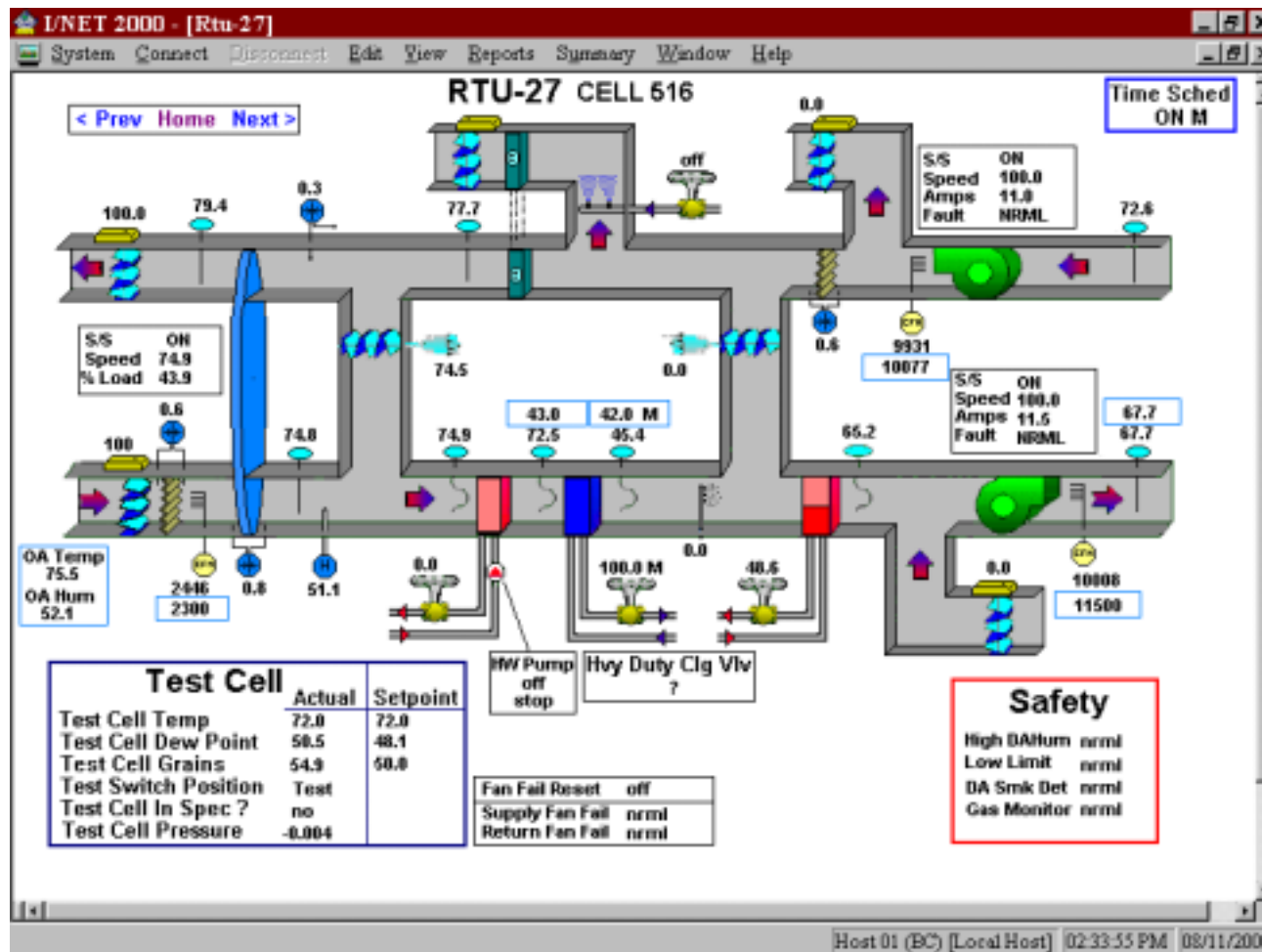
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# Typical Laboratory Test Cell AHU



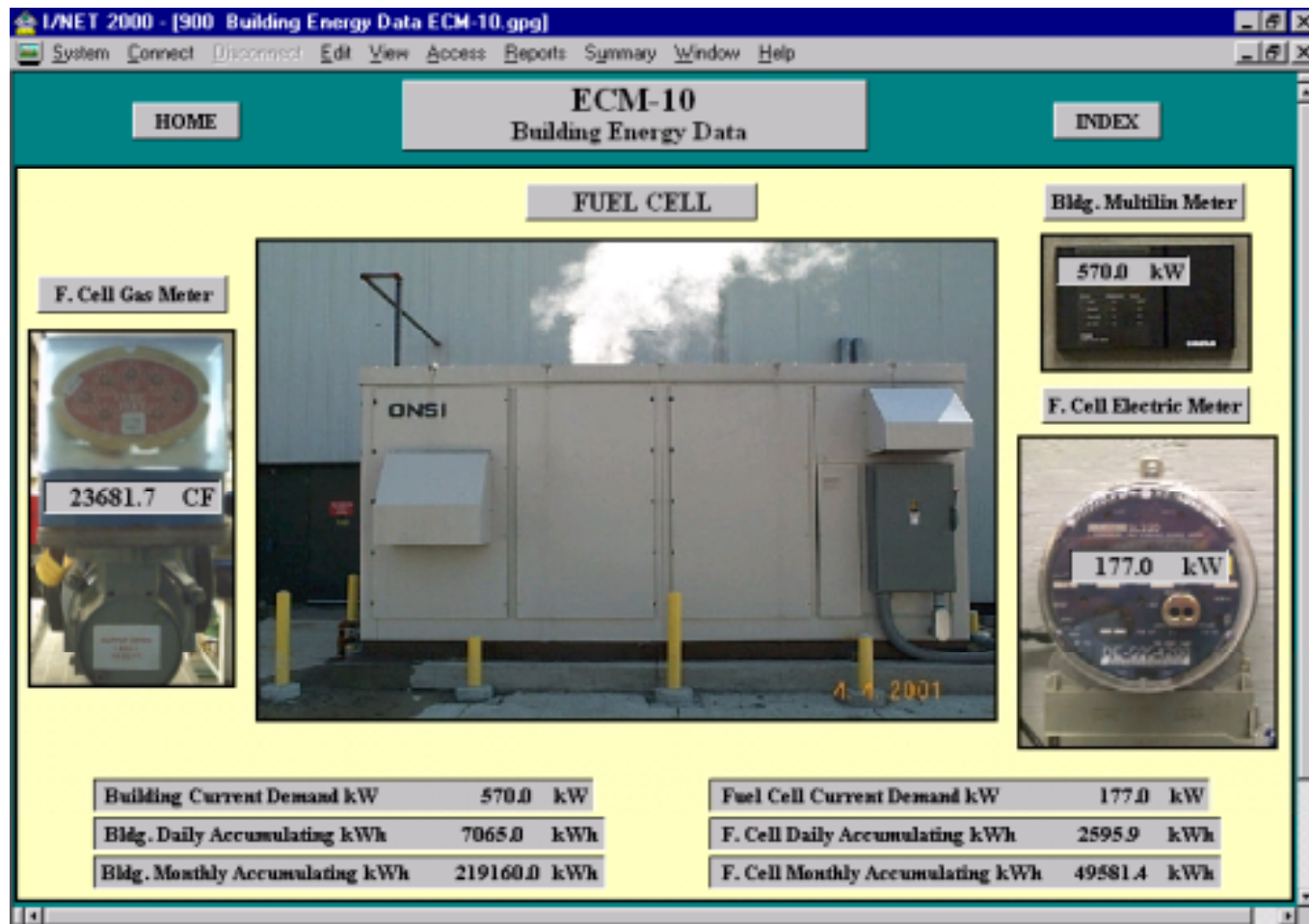
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# Fuel Cell Energy Accounting







# Total \$ Savings

(January 1, 2001 – December 31 2001)

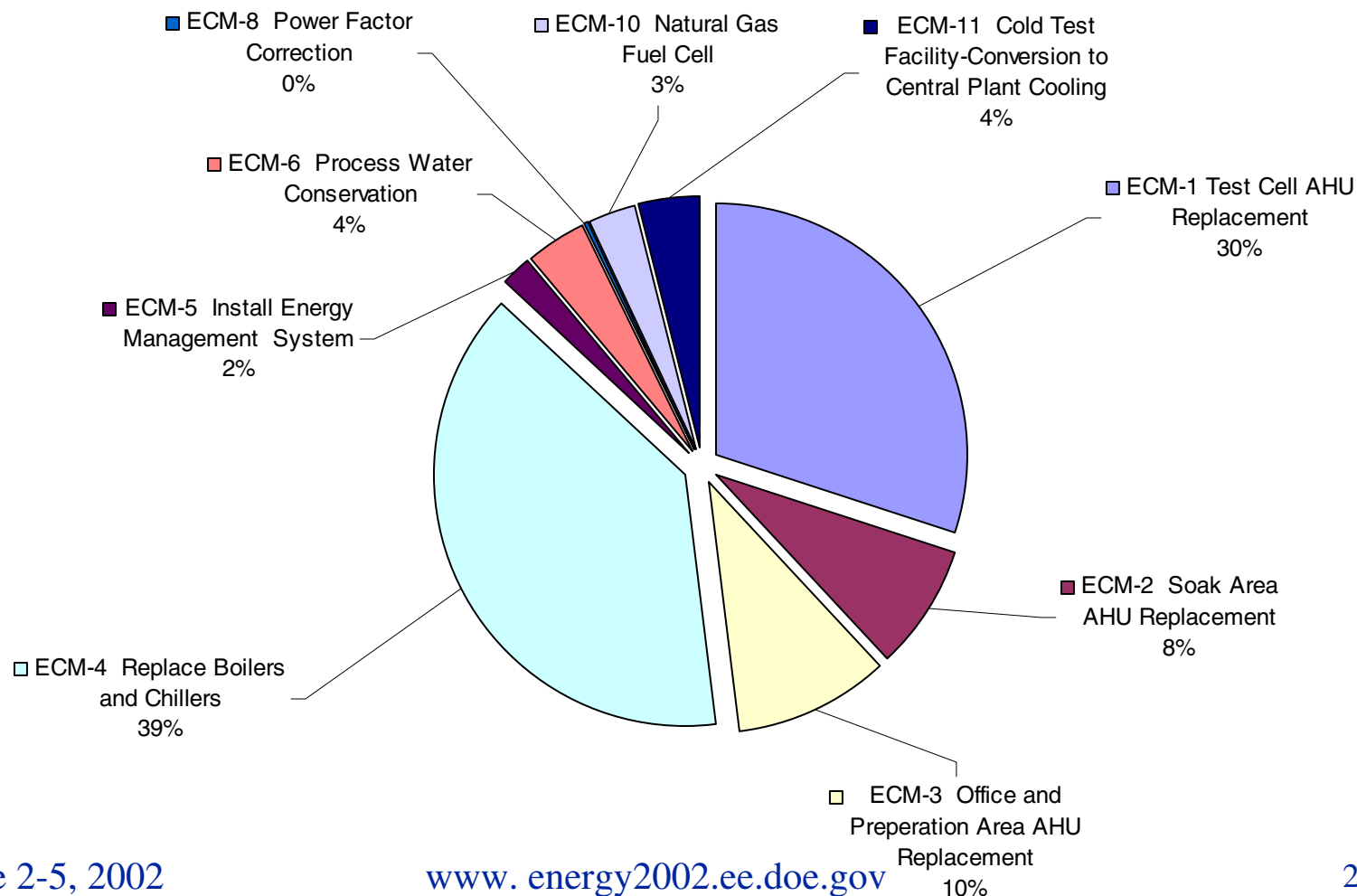
ECM	Electrical Savings (\$ kWh)	Water Savings (\$ Gal)	Fossil Fuel Savings (\$ Mtbu)	Total \$ Savings
ECM-1	\$66,854	\$27,184	\$213,837	\$307,875
ECM-2	\$12,005	\$4,757	\$70,290	\$87,052
ECM-3	\$35,857	\$7,836	\$60,425	\$104,117
ECM-4	\$22,188	\$0	(\$41,323)	(\$19,135)
ECM-5	\$3,522	\$0	\$13,958	\$17,480
ECM-6	(\$164)	\$46,785	(\$1,726)	\$44,895
ECM-8	\$0	\$0	\$0	\$0
ECM-10	\$34,784	\$0	(\$33,871)	\$913
ECM-11	\$564	\$0	(\$305)	\$259
<b>Sub Total</b>	<b>\$175,610</b>	<b>\$86,562</b>	<b>\$281,284</b>	<b>\$543,456</b>
<b>Sub Total + Demand Charge of \$489, 434 = TOTAL SAVINGS</b>				<b>\$1,032,890</b>
<b>Annual Guaranteed Savings – Second Year</b>				<b>\$1,093,856</b>
<b>Less Annual Maintenance Savings – Second Year</b>				<b>\$205,062</b>
<b>Amount Above Guarantee</b>				<b>\$144,096</b>





# *Cost Savings By ECM*

*(January 1, 2001 – December 31, 2001)*





## *Emissions Reductions*

Electrical & Fossil Fuel Savings			Emissions Offsets (Combined)		
ECM	kWh	Mbtu	CO <sub>2</sub> (tons)	NO <sub>x</sub> (tons)	SO <sub>2</sub> (tons)
1	2,282,727	50,296,092	4,805	7.5	10.4
2	409,922	16,532,768	1,287	1.7	1.98
3	1,249,443	14,212,372	1,876.2	3.4	5.5
4	757,603	-9,719,424	100	1.18	3
5	120,271	3,283,019	288.8	.4	.55
6	-5,604	-406,013	-27.7	-.03	-.03
8	0	0	0	0	0
10	1,187,717	-7,966,809	568.1	2.2	4.9
11	19,270	-71,739	12.47	.03	.08
<b>TOTAL</b>	<b>6,021,349</b>	<b>66,160,266</b>	<b>8,910</b>	<b>16.5</b>	<b>26.5</b>



## *Trading Value*

	Electrical (kWh)	Natural Gas (Mtbu)	CO <sub>2</sub> (tons)	SO <sub>2</sub> (tons)	NO <sub>x</sub> (tons)
<b>Savings</b>	6,021,349	66,160,266	8,910	26.5	16.5

- ❑ Retire carbon
- ❑ NO<sub>x</sub>: = \$7,425 to \$29,700 (16.5 tons x 0.9 (MDEQ air quality retirement) x \$500 to \$2000)\*
- ❑ Federal SIP NO<sub>x</sub> : forward trade for 2003: 16.5 tons x \$5,900 = \$97,350
- ❑ SO<sub>2</sub>: \$13,250 to \$53,000 (26.5 tons x \$500 to \$2000)\*

\* values based on Michigan ERC



## *Intangible Benefits*

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### What Else Do We Gain?

- ❑ Ability to make major upgrades
- ❑ Meet Executive Order 13123 goals
  - Executive Order does not exempt laboratories
- ❑ Model for other laboratory facilities
- ❑ Living agency's mission